

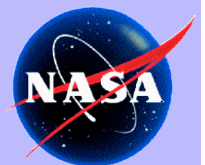
# **The GEWEX Radiative Flux Assessment Project**

**4th CERES-II Science Team Meeting**  
**1-3 November 2005**

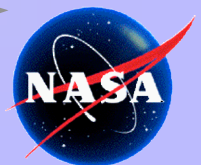
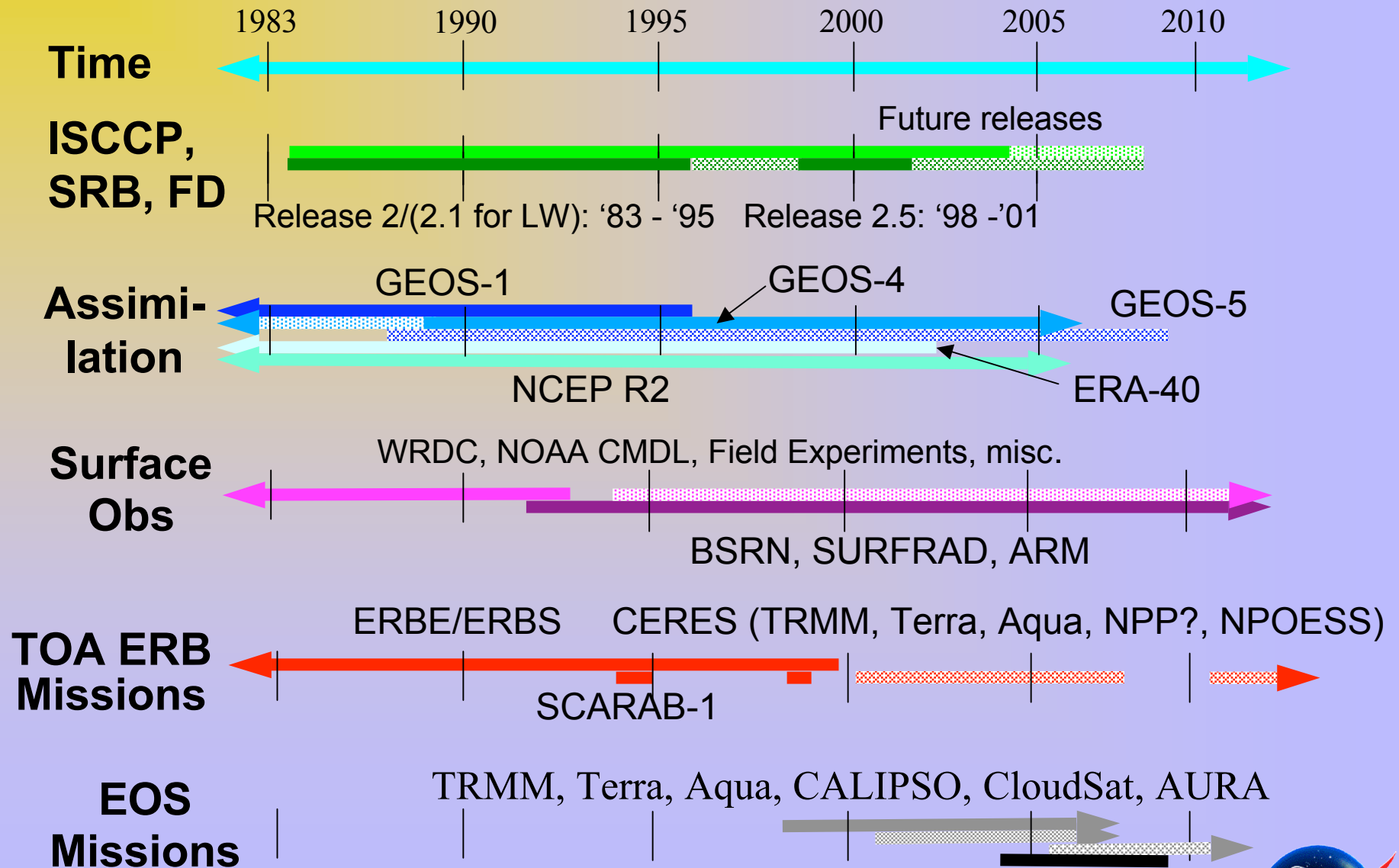
**Presenter: Paul Stackhouse (NASA LaRC)**

**Oversite Committee: Atsumu Ohmura (ETH), Erhard Raschke  
(U. of Hamburg), William Rossow (NASA GISS), Paul  
Stackhouse (NASA LaRC) and Bruce Wielicki (NASA LaRC)**

**Contributors to talk and web site: G. Louis Smith and Laura  
Hinkelman (NIA), GEWEX SRB Team (Stephen J. Cox, Shashi K.  
Gupta, J. Colleen Mikovitz, Marc Chiacchio, and Taiping Zhang -  
AS&M), LaRC Atmospheric Science Data Center (Juliet Pao,  
Walter Baskin and others), William Rossow (NASA GISS),  
Ellsworth Dutton (NOAA) and BSRN (ETH, Switzerland)**

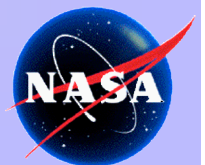


# Radiation Dataset Timeline



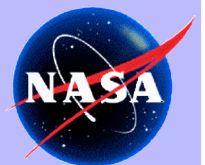
# Radiative Flux Assessment Overview

- Purposes:
  - To provide a comprehensive overview of our current understanding and capability to
    - *derive TOA and surface radiative fluxes from analysis of satellite observations*
    - *validate these fluxes with surface observations*
    - *simulate these fluxes with models and assimilation*
  - To provide information of the uncertainties and outstanding issues of the flux estimation at various time and space scales, particularly the long-term variability, by:
    - *providing uncertainty information from sources ranging from satellite calibration, input data sources, and assumptions (particularly in regards to spatial and temporal gap filling)*
    - *comparing of surface fluxes to surface based measurements*
    - *intercomparing of various existing data products*
    - *identifying largest uncertainties and needs*
  - To detail methods and uncertainties in such a way as to be useful for the future IPCC reports on long-term data uncertainty.
  - To develop climate system observation requirements for radiative fluxes and compare to current product accuracies.
  - To develop a test bed of current satellite radiative budget products and surface measurements and assess current GCM and reanalysis products.



# GEWEX RFA Activities to Date

- **1st Workshop held (Oct. 2004)**
  - Discussed issues
  - Developed pieces of draft document
  - Assigned TOA and surface groups
- **Draft Document Outline**
  - Proposed intercomparison activities
- **Web Site Now Operational**
  - Includes document framework
  - Provides for ingest and download of all data sets
- **Preliminary Results**
  - Raschke et al presentation (SRB v. ISCCP FD)
  - Preliminary ISCCP FD, SRB, CERES, and ERBE intercomparisons

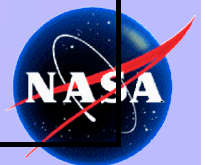


# Surface Data Product Time and Space Scale Matrix

<b>Space Scale Averaging</b>	Global	A				A	A	A	A	A	A
	Zonal	A				A	A	A	A	A	A
	1000 km	A	A	A	A	A	A	A	A	A	A
	280 km		A	A	X	A	A	A	A	A	A
	100 - 120 km	X	X	A	X	A	A	A	A	A	A
	40 - 60 km	X	X	A	A	A	A	A	A	A	A
	20 - 40 km	X		A	A	A	A	A	A	A	A
	5 - 10 km	X	X	X	A	A	A	A	A	A	A
	< 2 km	X				A	A	A	A	A	A
		Instantaneous	15-30 min	1 hour	3 hour	daily	pentad	month/monthly diurnal	seasonal	annual	decade
<b>Time Scale Averaging</b>											

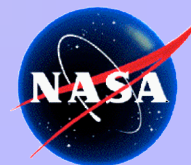
X - Native space and time averaging  
A - Existing or derivable by averaging existing data products

Cloud object  
Synoptic  
Intermediate  
Climate



# Flux Assessment Draft Plan: TOA

- Provide overview of current TOA flux estimation products including: ERBE (Scanner/Nonscanner), CERES, SCARAB, ISCCP FD, GEWEX SRB, NOAA Pathfinder and reanalysis
- Intercompare SWup, LWup, net; all-sky and clear-sky:
  - Monthly gridded product maps
  - Monthly time series (global and zonal; land and ocean; Hovmeuller)
  - Seasonal gridded maps of diurnal cycle
  - Characterize variability at various time and space scales
    - *Observation products*
    - *Model products*
  - Compare Meteorological Regimes and Cloud Systems
    - *Classify 250 km/daily meteorological regime using ISCCP for 2 bands (tropics and middle latitudes)*
    - *Use CERES cloud object classifier for individual cloud systems*
  - Time series at selected surface sites (collaborate w/ surface)
  - High Space and Time Intercomparison: GERB area, for June – July 2004
  - Error budget intercomparison
- Provide web-based data portal for data producers and users



# SW TOA Flux Intercomparison

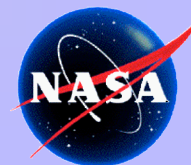
(Row - Column; Bold direct comparison; remainder inferred;  
Fluxes normalized relative to  $240 \text{ W m}^{-2}$ )

	ERBS Sc	ERBS NS	ScaRaB 1	CERES /TRMM	ScaRaB 2	CERES FM-1	CERES FM-2	CERES FM-3	CERES FM-4
ERBS Sc	-	<b>-5.4</b>	-4.5	-1.8	-5.2	-2.0	-1.7	-1.1	-1.2
ERBS NS	<b>0.3</b>	-	<b>0.9</b>	<b>3.6</b>	-0.2	3.4	3.7	4.3	4.2
ScaRaB 1	0.5	<b>0.4</b>	-	2.7	-0.7	2.5	2.8	3.4	3.3
CERES/ TRMM	0.9	<b>0.9</b>	1.0	-	<b>-3.4</b>	<b>-0.2</b>	0.1	0.9	0.6
ScaRaB 2	1.7	1.7	1.7	<b>1.4</b>	-	3.2	3.5	4.1	4.0
CERES FM-1	1.2	1.1	1.2	<b>0.7</b>	1.6	-	<b>0.3</b>	0.9	<b>0.8</b>
CERES FM-2	1.3	1.2	1.3	0.9	1.6	<b>0.5</b>	-	0.6	0.5
CERES FM-3	1.2	1.2	1.2	0.7	1.6	0.2	0.5	-	<b>-0.1</b>
CERES FM-4	1.2	1.1	1.2	0.7	1.6	<b>0.1</b>	0.5	<b>0.2</b>	-

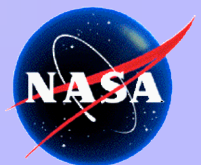
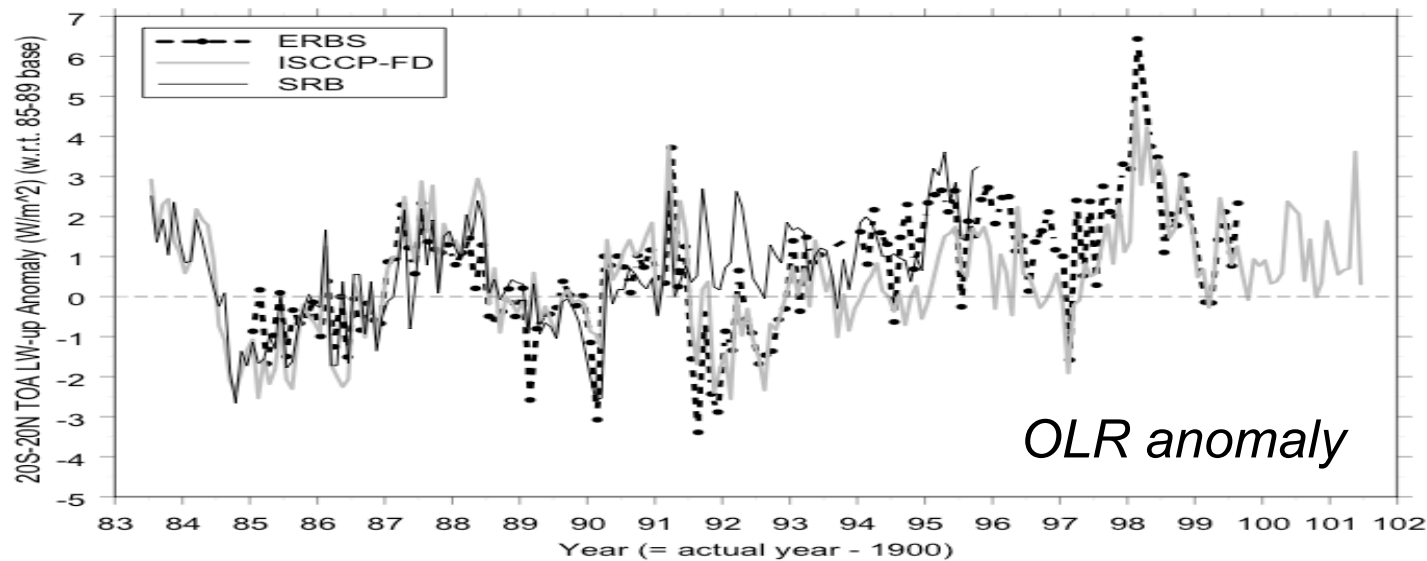
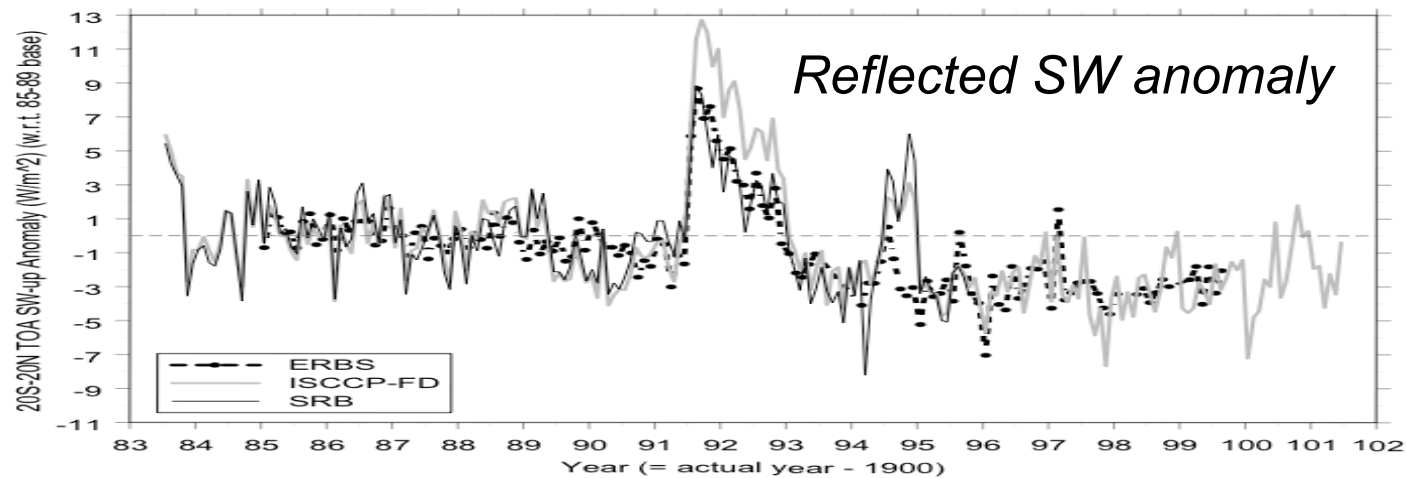
Mean  
Differ-  
ences

Standard Deviations

(Smith et al., 2005, submitted JGR)



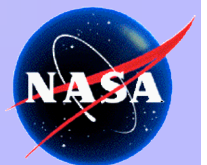
# TOA Time Series Intercomparison





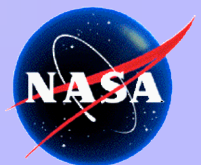
# Flux Assessment Draft Plan: Surface

- **Provide overview of surface measurements networks**
  - Poll existing data sets: spatial and temporal extent; calibration
  - Select long and short-term datasets
  - Summarize surface measurement needs and issues
- **Provide overview of current surface flux estimation products including:**
  - Global: GEWEX SRB, ISCCP FD, ESRB, CERES SARB and SOFA, UMD ISCCP and MODIS based (Pinker), SWnet (Li), ERA 40, NCEP R2, GEOS-4
  - Regional: GEWEX CSE's, Tropical Pacific (Chou), MSG (2-3), Polar Fluxes (Key), Brazilian products, UMD GOES and ISCCP DX, SUNY-Albany
- **Satellite-surface Intercomparisons for: SW down (total, direct, diffuse), LW down; all-sky and clear-sky**
  - Statistical Intercomparisons: various space and time scales
  - Time series intercomparisons: variability, systematic
  - Summarized satellite-surface issues



# Flux Assessment Draft Plan: Surface

- **Satellite-based surface flux product intercomparisons for: SW down (total, direct, diffuse), SW up, albedo, LW down, LW up, emissivity; all-sky and clear-sky (for fluxes)**
  - **Monthly gridded product maps**
  - **Monthly time series (global and zonal; land and ocean)**
  - **Seasonal gridded maps of diurnal cycle**
  - **Characterize variability at various time and space scales**
    - *Observation products*
    - *Model products*
  - **Compare meteorological regimes and cloud systems**
    - *Classify 250 km/daily meteorological regime using ISCCP for 2 bands (tropics and middle latitudes)*
    - *Use CERES cloud object classifier for individual cloud systems*
  - **Time series at selected surface sites (collaborate w/ surface)**
  - **High space and time intercomparison: GERB area, for June – July 2004**
  - **Error budget intercomparison**
- **Provide web-based data portal for data producers and users**



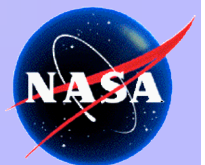
# Surface Measurement Example

## Uncertainty Matrix:

### *BSRN Operational Measurement Quality*

RMS Uncertainties for Radiative Measurements (Ohmura et al, 1998, BAMS; Michalsky et al., 1998; Shi and Long, 2002, Dutton et al., 2001; Ellis Dutton personal comm.)							
Quantity (Instrument)	1 Minute Avg. (1 Hz sampling) (W m <sup>-2</sup> )	1 Hour (W m <sup>-2</sup> )	1 Day (W m <sup>-2</sup> )	1 Month (W m <sup>-2</sup> )	1 Year (W m <sup>-2</sup> )	10 Years	Thermal Offset
LW Broadband (pyrgeometer)	5 - 7 (2%)	5	3 -- 5	3 -- 5	3 -- 5	??	---
SW Broadband Global (direct+diffuse, pyranometer)	25+ (4-5%)	8 -- 20	5 -- 15	5 -- 15	5 -- 15	??	up to -3%
SW Broadband Direct (NIP)	5 - 15 (1.5%)	1% or 2	1% or 2	1% or 2	1% or 2	??	---
SW Broadband Diffuse (shaded pyranometer)	5 -- 7 (3-4%)	5 -- 15	5 -- 15	5 -- 12	5 -- 12	??	up to -10
SW Broadband Total (shaded pyranometer + NIP)	10 -- 15 (3.0%)	5 -- 15	5 -- 15	5 -- 12	5 -- 12	??	up to -10

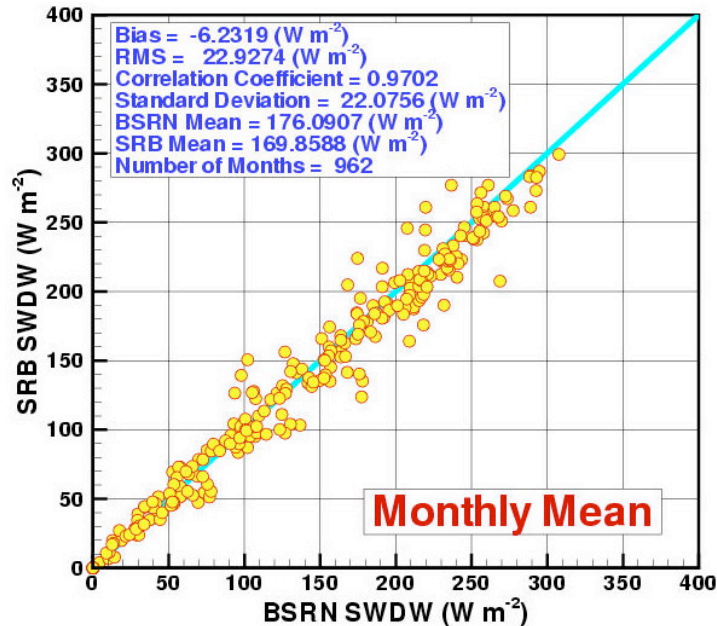
*Challenge: Derive similar tables for each network; survey and classify measurements (i.e., land, ocean)*



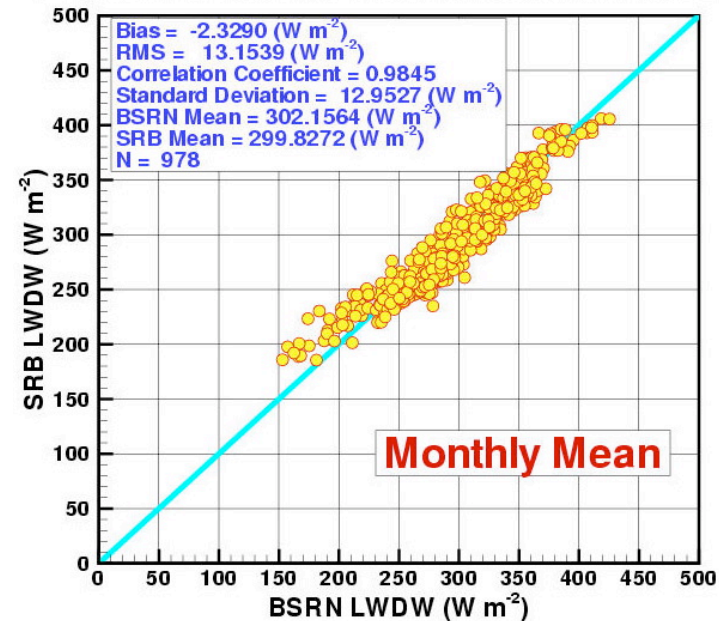
# SRB vs. BSRN

All sites, 1998-2001

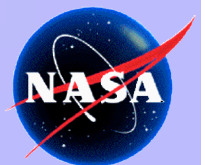
SW



LW

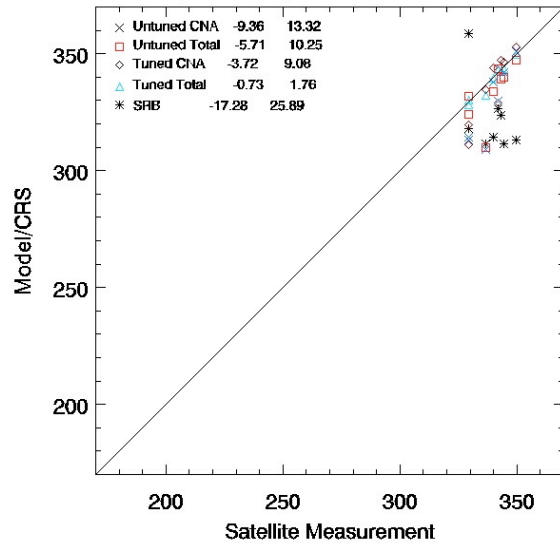


Quantity (Instrument)	Instantaneous Gridded (1 Hour Averaged Obs., $\text{W m}^{-2}$ )	1 Day ( $\text{W m}^{-2}$ )	1 Month ( $\text{W m}^{-2}$ )	Monthly Averaged 3- hourly	Longer time averages
LW Broadband	30 - 35	23 -- 29	12 -- 17	18 -- 22	??
SW Broadband	75 - 95	35 -- 45	15 -- 25	38 -- 42	??

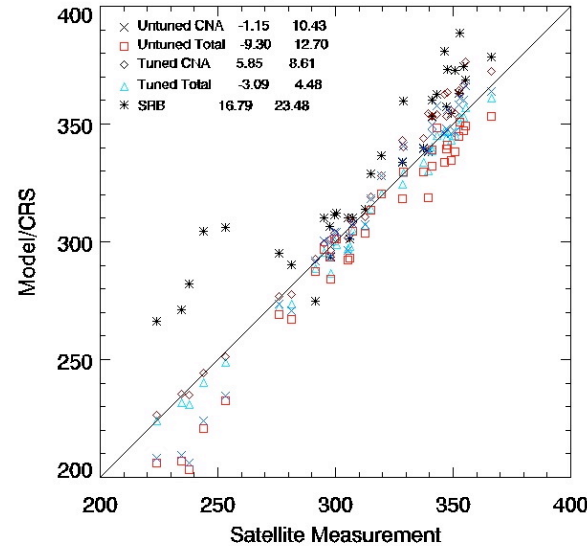


# Multi-Dataset Comparisons

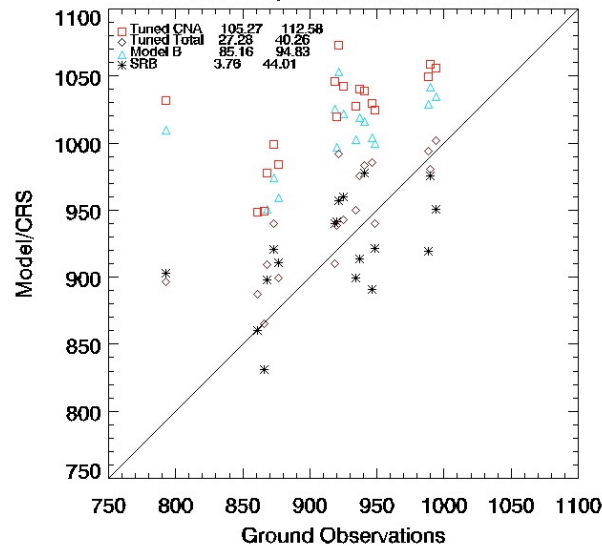
SW TOA Up at Footprint Times for Jul 2000



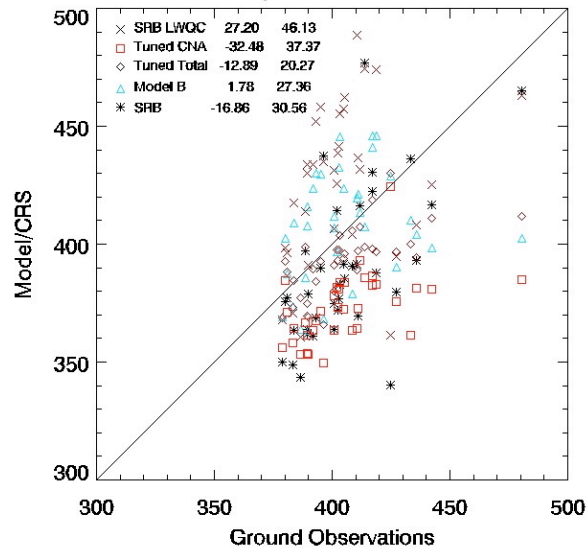
OLR at Footprint Times for Jul 2000



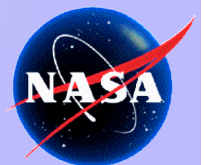
DSF at Footprint Times for Jul 2000



DLF at Footprint Times for Jul 2000



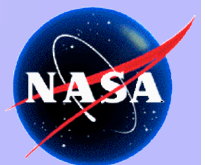
- SRB and surface data matched to CERES overpass times
- Surface BSRN site: Saudi Solar Village
- July 2000



# GEWEX RFA Web Site Status


Address: <http://eosweb.larc.nasa.gov/GEWEX-RFA>

- Link to important information about the project and how to participate (all comments welcome)
  - 1st draft of all documents available on web site
  - Can list the categories of data products that will eventually be available
- “How to participate” document gives step by step instructions as to how to prepare and submit data sets to the web site
  - Ingest infrastructure written and tested
  - Currently populating archive with SRB and CERES data
- Data ordering
  - Code for ordering data is complete and requires testing
  - Will be implemented as soon as possible.






# GEWEX RFA Web Site



ATMOSPHERIC  
SCIENCES  
DATA CENTER

## GEWEX Radiative Flux Assessment



The ultimate goal of the [Global Energy and Water Cycle Experiment \(GEWEX\)](#) global data analysis projects is to obtain observations of the elements of the global energy and water cycle with sufficient detail and accuracy to diagnose the causes of recent climate variations in terms of the energy and water exchanges among the main climate components (atmosphere, ocean, land, cryosphere, biosphere). The GEWEX-Radiative Flux Assessment (RFA) project will provide a forum for consistent analysis of long-term radiative flux products, primarily top-of-atmosphere (TOA) and surface fluxes, to establish a foundation for better global radiation budget analysis.

[Assessment Activity Summary](#) | [How to Participate](#) | [File Conventions](#) | [Register for GEWEX-RFA news list](#) | List of Participants (TBD) | [Acknowledgement](#)

Top of Atmosphere (TOA) Data Products	Surface Data Products	Ground-Based Measurements	Cloud Regimes
<ul style="list-style-type: none"><li>• <a href="#">Maps</a></li><li>• <a href="#">Time Series</a></li><li>• Hovmöller Diagrams</li><li>• High Time/Space Resolution</li></ul>	<ul style="list-style-type: none"><li>• <a href="#">Maps</a></li><li>• <a href="#">Time Series</a></li><li>• Hovmöller Diagrams</li><li>• High Time/Space Resolution</li></ul>	<ul style="list-style-type: none"><li>• <a href="#">Time Series</a></li></ul>	


### Acknowledgement

When data from the GEWEX Radiative Flux Assessment are used in a publication, we request the following acknowledgment be included: "The GEWEX Radiative Flux Assessment data were obtained from the NASA Langley Research Center Atmospheric Sciences Data Center."

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[ASDC Home Page](#) | [Questions/Feedback](#)

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Responsible NASA Official: Bruce R. Barkstrom, Ph.D.  
Site Administration/Help: NASA Langley ASDC User Services ([larc@eos.nasa.gov](mailto:larc@eos.nasa.gov))  
[\[Privacy, Security, Notices\]](#)  
Last Updated: Thu Sep 29 2005 09:03:46 GMT-0400 (EDT)




# GEWEX RFA Web Site


GEWEX Top of Atmosphere (TOA) Data Products: Time Series

http://dutchcraft.larc.nasa.gov/REVIEW/GEWEX-RFA/toa\_products/time\_series.html

Getting Started Latest Headlines




## GEWEX Top of Atmosphere (TOA) Data Products: Time Series



Averaging interval	<input checked="" type="radio"/> All available averaging intervals <input type="radio"/> Monthly <input type="radio"/> Weekly <input type="radio"/> Daily <input type="radio"/> Hourly
Spatial scale	<input checked="" type="radio"/> All available spatial scales <input type="radio"/> Global <input type="radio"/> North Hemisphere <input type="radio"/> South Hemisphere <input type="radio"/> Land <input type="radio"/> Ocean Zonal: <input type="radio"/> All available zones <input type="radio"/> Zone set 1 (15°/30° zones) <input type="radio"/> 20°S - 20°N <input type="radio"/> 60°S - 60°N Region: Not yet specified Meteorological regime: Not yet specified Site: <input type="text" value="All available sites"/>
Sky condition	<input checked="" type="radio"/> All available sky conditions <input type="radio"/> Clear sky <input type="radio"/> All sky
Parameter	<input checked="" type="radio"/> All available parameters <input type="radio"/> SW downward flux <input type="radio"/> SW upward flux <input type="radio"/> SW net (total down + up) flux <input type="radio"/> SW broadband albedo <input type="radio"/> LW upward flux <input type="radio"/> Total (SW + LW) net flux

[GEWEX-RFA](#) | [ASDC Home Page](#) | [Questions/Feedback](#)



Responsible NASA Official: Bruce R. Barkstrom, Ph.D.  
Site Administration/Help: NASA Langley ASDC User Services ([larc@eos.nasa.gov](mailto:larc@eos.nasa.gov))  
[\[Privacy, Security, Notices\]](#)  
Last Updated: Wed Jun 08 2005 13:25:31 GMT-0400 (EDT)



# Data Availability: Live Access Server

MY NASA DATA Live Access Server

http://mynasadata.larc.nasa.gov/las/servlets/constrain?va

Getting Started Latest Headlines

Firefox prevented this site from opening a popup window. Click here for options...

## MY NASA DATA

Mentoring and inquiry using NASA Data on Atmospheric and earth science for Teachers and Amateurs

+ MY NASA DATA HOME + DATA ACCESS + LESSON PLANS + COMPUTER TOOLS + SCIENCE FOCUS + GLOSSARY

[single data set](#) [compare two](#)

[Select Datasets](#)  
[Show Variables](#)  
[Set Constraints](#)  
[View Output](#)  
[Output Options](#)  
[Previous Output](#)  
[Define variable](#)  
[About Live Access Server](#)  
LAS UI Version 6.4

[Datasets](#) > [Atmosphere](#) > [Atmospheric Radiation](#)  
Variable(s): **Pinker All-Sky Downward Shortwave Monthly Surface Irradiance (SRB)**

Select your desired view (geometry of output) and output (type of product).  
Then set the 4-D region (lon-lat-depth-time) and any additional constraints. [Help](#)

**Select view:** Longitude-Latitude Map [Next >](#)  
**Select output:** Shaded plot  
**Select region:** Full Region [Go](#) [Use map applet](#)

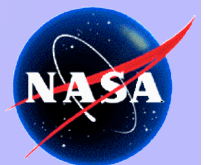
[Help](#) [Reset](#)

89 N 180 W 180 E 89 S [Go](#)

[Zoom +](#) [Zoom -](#)

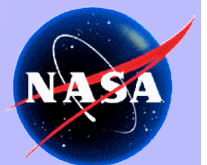
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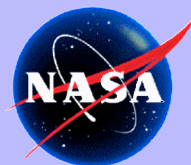
Connecting to mynasadata.larc.nasa.gov...



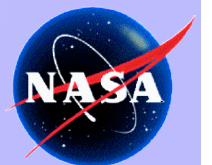
# Radiation Flux Assessment Next Steps

- Finalize Radiation Flux Assessment Plan
  - Use the established web site to solicit input and contributing data sets from the community
  - Establish news group for information exchange
  - Continue to prioritize activities
- Data ingest and analysis
  - Begin submittal of data products from participants
  - Make selection of and begin collection of surface measurement datasets
  - Begin to derive statistics of own datasets for submission including comparisons against surface site data (participants or collaborators?)
  - Modify web site to accommodate posting of results
- Collaborative analysis towards draft assessment document ~1 year from now.
  - Hold follow-up workshop: Feb. 2006?
- **Need Participants!**

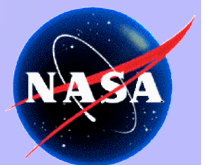
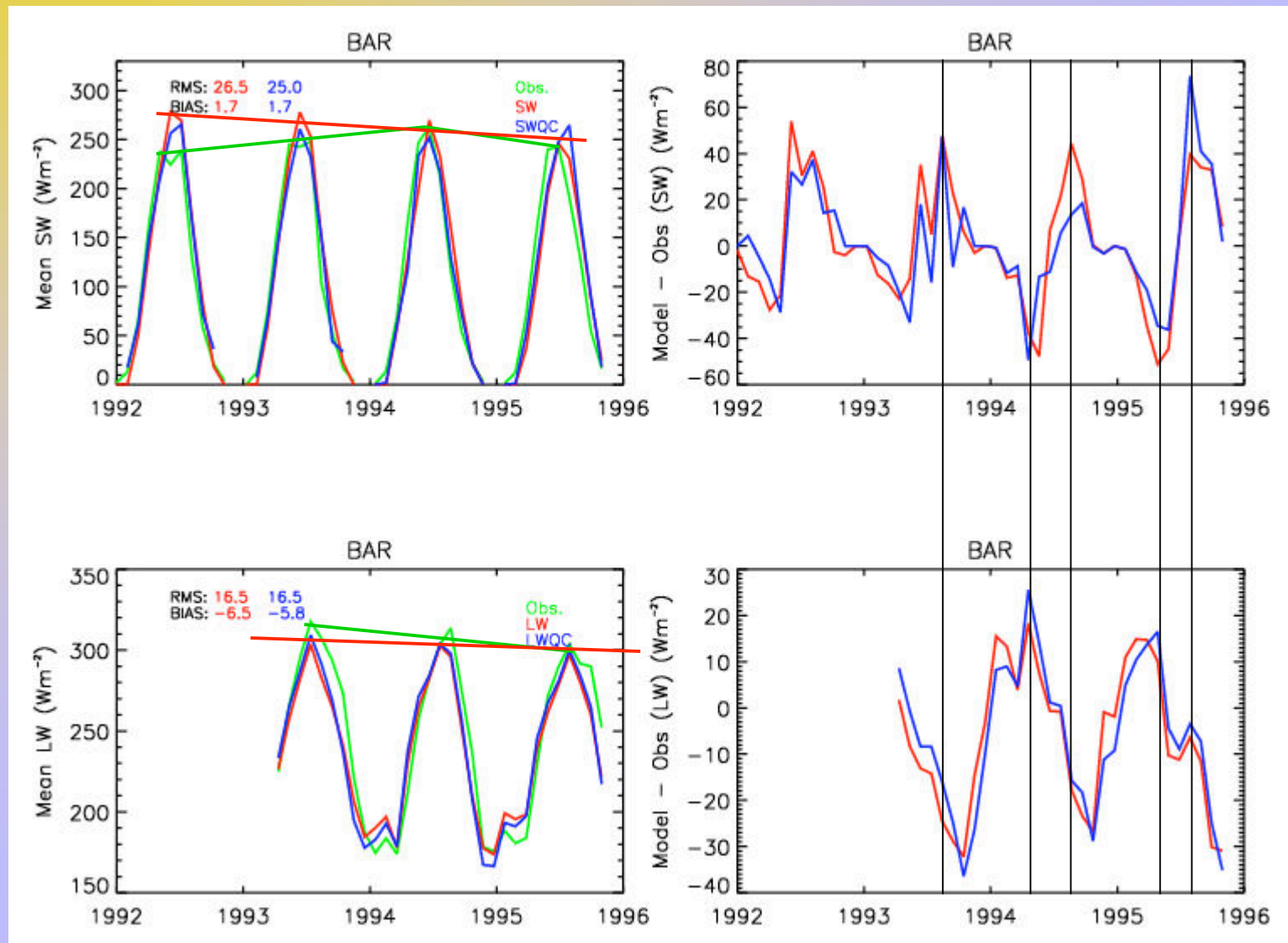




# Extra Slides

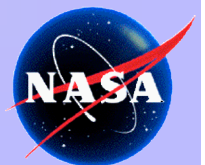


# Establishing Long-term Data Quality



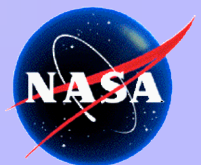
# Workshop Purposes

- **Develop a draft flux assessment document outline to facilitate the flux assessment task.**
- **Use the outline to:**
  - focus comparison tasks
  - clarify and set writing assignments
  - clarify and set schedule
  - clarify crosscutting and overview writing assignments
  - look for missing items in the approach
- **Outline should be logically “complete”**
  - some sections may be only minimally covered in this assessment and call out for future needs
- **Outline to be finalized via interaction of participants after incorporating results of the meeting**



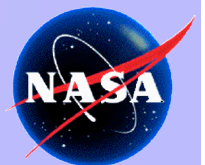
# 1st Workshop Results

- **PURPOSE:** Develop a draft flux assessment document outline to facilitate the flux assessment task.
- **Workshop Total Participants: 29**
  - **Initiators and Organizers:** Raschke and Ohmura
  - **GRP Flux Assessment Committee Members:** Ohmura, Raschke, and Rossow, Stackhouse (co-chair) and Wielicki (co-chair)
- **Two subgroups formed:**
  - **TOA Fluxes:** Wielicki, chair
  - **Surface Fluxes:** Stackhouse, chair
- **Agenda:**
  - Overview talks (Rossow, Wielicki)
  - Talks emphasizing flux accuracy needs - from data users
  - Data product overview talks (many talks)
  - Data analysis talks (several)
  - Plenary and subgroup discussions to:
    - *draft sections of the assessment document outline*
    - *discuss analysis plans*



# Flux Assessment Draft Plan: Summary and Introduction

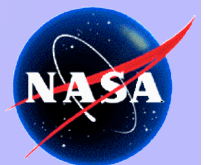
- Executive Summary
- Introduction
  - Assessment Objectives
    - Decadal variability
    - Defining accuracy of TOA and Surface data
    - Long term goal is merged TOA, Atmosphere, Sfc Data
  - Observation System Requirements
    - Climate model natural variability: defining the limits of observing system accuracy.
    - Observing requirements driven by climate radiative forcing, cloud feedback, aerosol indirect effect issues.
    - Long term goal is climate prediction uncertainty driven requirements (climate prediction.net example)





# Flux Assessment Draft Plan

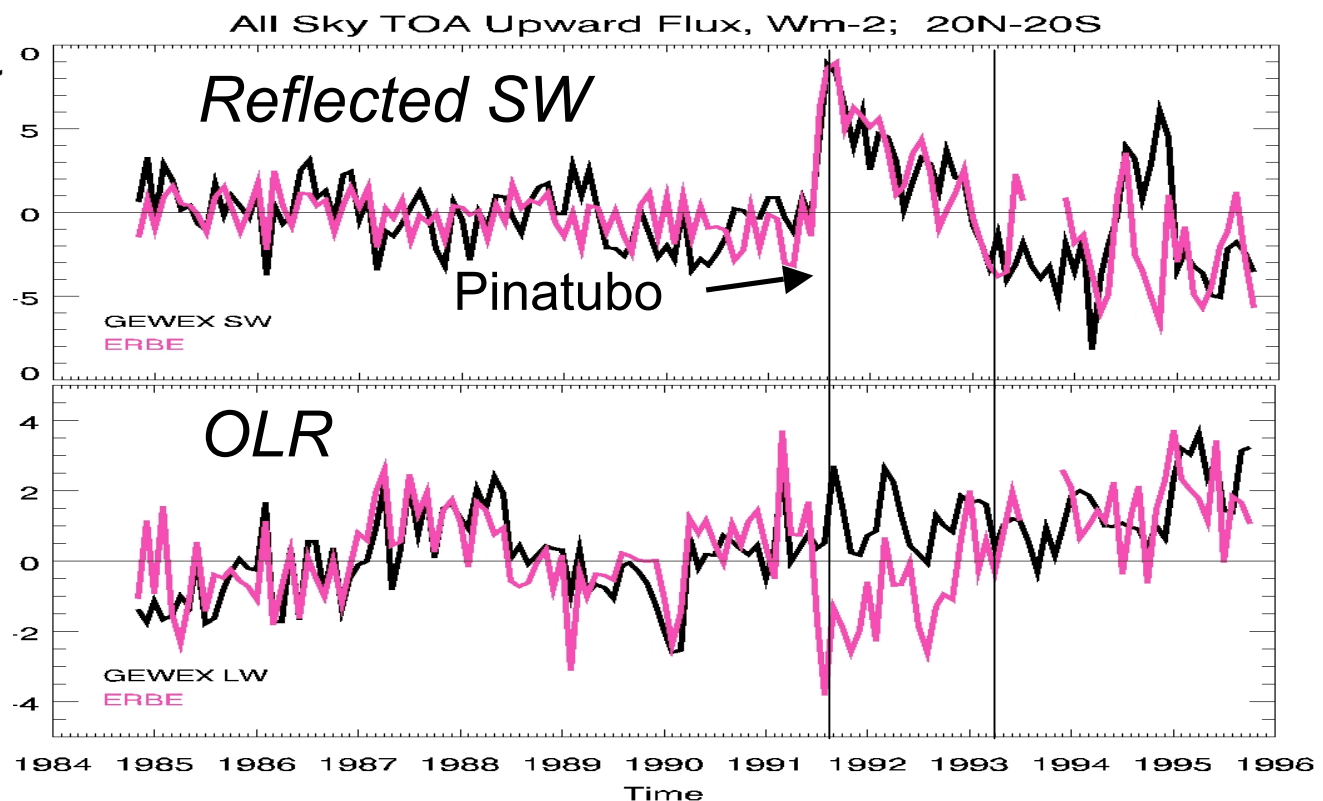
- Contributed Chapters
- Lessons Learned
  - Data Management
    - *Data Access and Delivery (GEBA example)*
    - *Data Analysis Tools (Live Access Server)*
    - *Data Archive: long-term archive issues*
  - Data gap issues for Satellite and Surface measurements
- Observation vs. Climate Model Incomparisons in nonparallel world
  - Twilight issues
  - Reference altitude
- Final Assessments and Recommendations
  - Assessment of TOA fluxes
  - Assessment of Surface fluxes
  - Assessment of Atmospheric Divergence
- Identification of Key issues
- Appendix (contains more highly detailed information related to issues from calibration to radiative transfer, etc.)



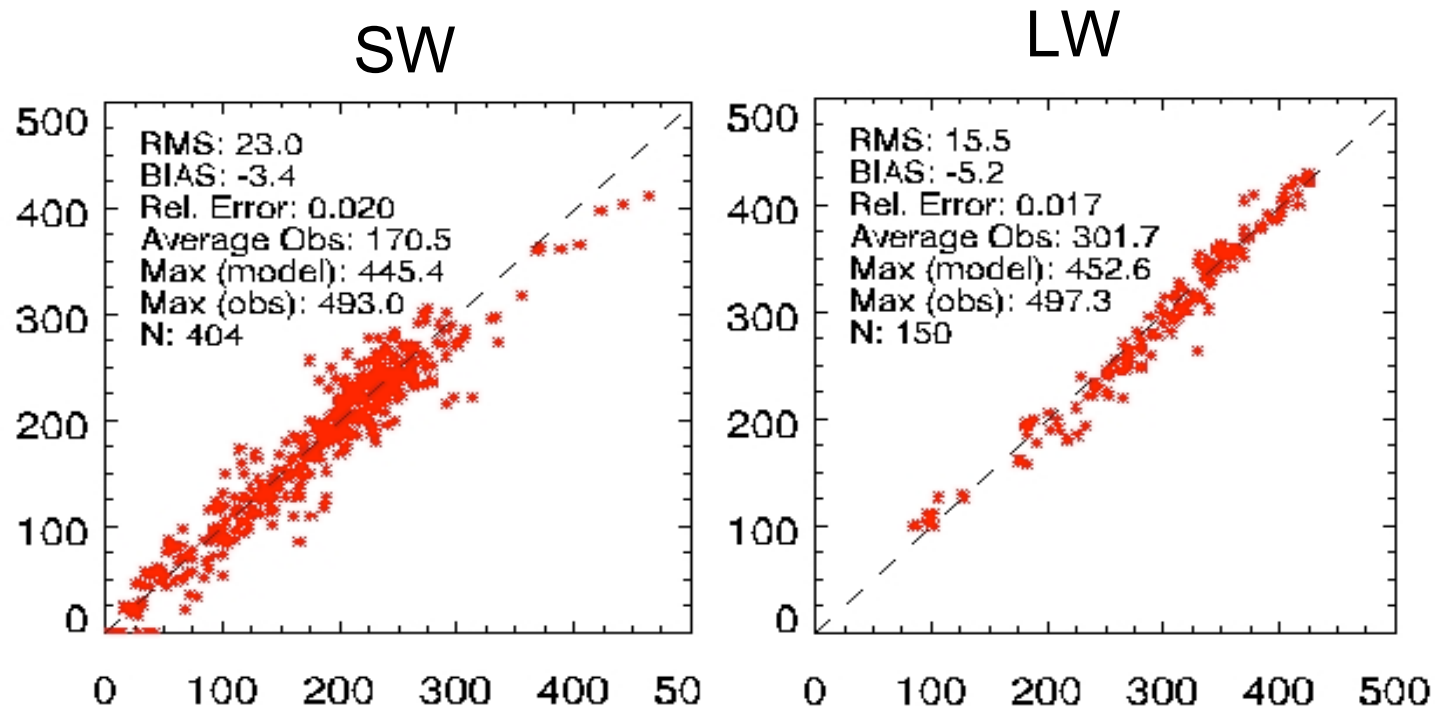
# SRB TOA vs. ERBE

TOA Upward Flux Deseasonalized Anomaly  
Relative to '85 - '89 ( $\text{W m}^{-2}$ )

ERBE Non-Scanner Measurements	Nov84-Oct95						
	Latitude Zones						
	60°S - 60°N	0° - 60°S	0° - 60°N	20°S - 20°N	30°S - 30°N	30°S-60°S	30°N - 60°N
GLW OLR (v2.1)	243.6	243.7	243.4	253.5	256.4	225.6	227.4
ERBE OLR	241.5	242.1	240.9	252.0	253.7	224.0	225.6
RMS	2.42	2.03	2.96	2.04	3.04	2.05	2.87
Bias	2.12	1.65	2.59	1.50	2.75	1.58	1.79
GSW TOAUP	100.4	99.2	101.6	98.4	96.9	104.5	105.5
ERBE TOAUP	94.1	93.0	96.2	93.9	93.2	96.2	98.5
RMS	7.94	9.26	7.46	5.23	4.38	12.52	10.45
Bias	6.27	6.28	5.46	4.54	3.77	7.24	7.09



# SRB vs. BSRN



Quantity (Instrument)	Instantaneous Gridded (1 Hour Averaged Obs., W m <sup>-2</sup> )	1 Day (W m <sup>-2</sup> )	1 Month (W m <sup>-2</sup> )	Monthly Averaged 3- hourly	Longer time averages
LW Broadband	30 - 35	23 -- 29	12 -- 17	18 -- 22	??
SW Broadband	75 - 95	35 -- 45	15 -- 25	38 -- 42	??



# Day-time LW TOA Flux Intercomparison

(Row - Column; Bold direct comparison; remainder inferred)

	ERBS Sc	ERBS NS	ScaRaB 1	CERES /TRMM	ScaRaB 2	CERES FM-1	CERES FM-2	CERES FM-3	CERES FM-4
ERBS Sc	-	<b>5.8</b>	1.3	1.1	3.3	4.6	4.5	3.6	3.2
ERBS NS	<b>0.1</b>	-	<b>-4.5</b>	<b>-4.7</b>	-2.5	-1.2	-1.3	-2.2	-2.6
ScaRaB 1	0.2	<b>0.2</b>	-	-0.2	2.0	3.3	3.2	2.8	1.9
CERES/ TRMM	0.4	<b>0.4</b>	0.4	-	<b>2.2</b>	<b>3.5</b>	3.4	2.5	2.1
ScaRaB 2	0.5	0.4	0.5	<b>0.2</b>	-	1.3	1.2	0.3	-0.1
CERES FM-1	0.5	0.4	0.5	<b>0.2</b>	0.3	-	<b>-0.1</b>	-1.0	<b>-1.4</b>
CERES FM-2	0.7	0.7	0.7	0.5	0.6	<b>0.5</b>	-	-0.9	-1.3
CERES FM-3	0.5	0.5	0.6	0.4	0.4	0.3	0.6	-	<b>-0.4</b>
CERES FM-4	0.5	0.4	0.5	0.2	0.3	<b>0.0</b>	0.5	<b>0.3</b>	-

Mean  
Differ-  
ences

Standard Deviations

(Smith et al., 2005, submitted)

